Indian Institute of Technology, Kharagpur -721302

Mid-Semester

Date: FN/AN; Time: 2 hours; Full Marks: 60; Number of Students 255

Spring Semester, 2013-2014; Department: E & ECE; II year B. Tech.;

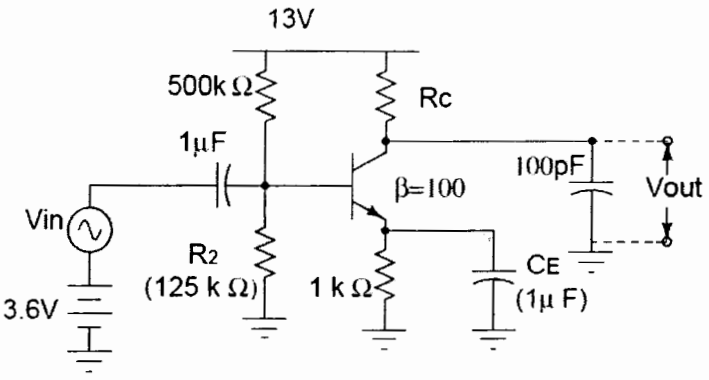
Subject no. EC 21008 Subject name: **Analog Electronic Circuits**

Instruction: Answer ***ALL*** questions and in the **same order** of the questions. Wherever it is necessary, you may use assumption(s) with reasonable justification.

Given: Saturation region drain current of an enhancement mode MOS transistor is,

$$|I_{DS}| = K\left(|V_{GS}| - |V_{th}|\right)^2\left(1 + \lambda|V_{DS}|\right)$$

Q. 1. For all parts of this question refer to the adjacent circuit.



(a) Assuming the transistor is in active region of operation find the value of the quiescent current I_{CQ} of the transistor.

(b) Find the maximum value of the resistor R_C up to which the transistor remains in active region of operation.

(c) For R_C is equal to 4kΩ, find the value of the maximum possible output signal swing (without "significant distortion").

(d) Draw small signal equivalent circuit of the amplifier.

(e) For R_C is equal to 4kΩ, evaluate the following parameters and neatly sketch the frequency response of the amplifier:

(i) The voltage gain in mid-frequency range

(ii) The lower cut-off frequency

(iii) The upper cut-off frequency

(f) For R_C is equal to 4kΩ,if the capacitor CE is removed then what shall be the voltage gain in mid-frequency range and the lower cut-off frequency of the amplifier?

(g) For R_C is equal to 4kΩ,if the resistor R_2 is removed then what shall be the operating point (I_{CQ} and V_{CEQ}) of the transistor?

[3 + 3 + 3 + 3 + 9 + 6 + 3 = 30]

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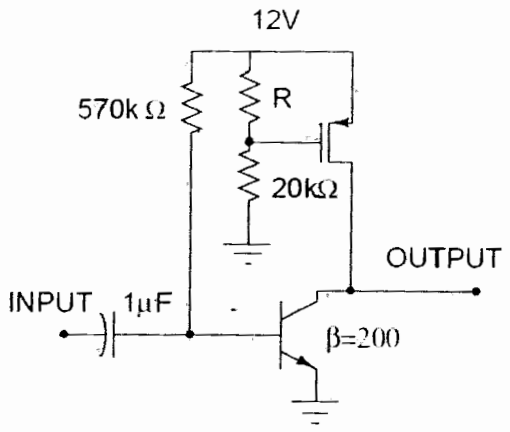
Q. 2. A common emitter amplifier with active load circuit is shown in the adjacent figure. Values of some parameters of the pMOS transistor are the following: Transconductance factor, K = 2mA/V^2 ; Threshold voltage, $|V_{Th}|$ = 3 V; Channel length modulation factor, λ = (1/70) V^{-1}. Values of the remaining parameters can be taken as that of ideal one. Similarly, for the n-p-n transistor, the Early voltage, V_A = 50V and values of the remaining parameters can be taken as that of ideal one.



(a) Find the value of the resistor R so that I_{CQ} = 2.02 mA and V_{CEQ} = 5V. Use this value of R for the subsequent parts of this question.

(b) Draw small signal equivalent circuit of the amplifier.

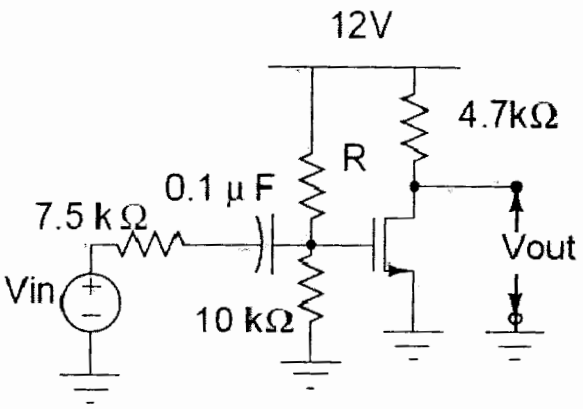
(c) Find the small signal gain of the amplifier.

(d) If you cascade two identical such amplifiers what will be the overall voltage gain

[3 + 3 + 3 + 6 = 15]

Q. 3. A common source amplifier circuit is shown in the adjacent figure. Values of some parameters of the transistor are the following: Transconductance factor, K = 1mA/V^2 ; Threshold voltage, V_{Th} = 2 V; Channel length modulation factor, λ = 0.01 V^{-1}. Values of the remaining parameters can be taken as that of ideal one.

(a) Find the value of the resistor R such that I_{DSQ} = 1mA.



(b) With the value of R that is obtained in the part (a) of this question, find the small signal voltage gain of the amplifier in mid-frequency range.

(c) With the value of R that is obtained in the part (a) of this question, find the maximum output signal swing without having "significant distortion".

(d) With the value of R that is obtained in the part (a) of this question, find the lower cutoff frequency of the amplifier.

(e) With the value of R that is obtained in the part (a) of this question, for V_{in} = 500 Sin((2000/3)t) mV, neatly sketch the output voltage V_{out}.

[3 + 3 + 3 + 3 + 3 = 15]